interactive simulation of electricity demand and production

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Appendix A: Technical acronyms and abbreviations

BMD	Brede Maatschappelijke Discussie (National energy debate)
CHP	Combined Heat and Power (Cogeneration)
COP	Coefficient Of Performance
EP	Electricity Price
EUE	Expected Unserved Electricity
FGD	Flue-Gas-Desulphurization
GDP	Gross Domestic Product
GDPC	Gross Domestic Product per Capita
GEE	GDP-Electricity-Elasticity
IEEE	The Institute of Electrical and Electronics Engineers, Inc.
IMAGE	Integrated Model for the Assessment of the Greenhouse Effect
LDC	Load Duration Curve
LEO	Landelijke Elektriciteits Optimalisatie (National Electricity Optimization)
LF	Load Factor
LOLP	Loss Of Load Probability
LRPE	Long Run Price Elasticity
MU	Monetary Units
NOPEC	NOn Polluting Energy Concept
PV	Photo Voltaic cells
RAINS	Regional Acidification Information and Simulation
RF	Reserve Factor
SCELEC	SCenarios for the ELECtricity supply
SCR	Selective Catalytic Reduction
Sep	Samenwerkende ElektriciteitsProductiebedrijven (Dutch Electricity Generating Board)
SMD	Simultaneous Maximum Demand
STAG	STeam-And-Gas
T&D	Transmission and Distribution
TERI	Tata Energy Research Institute
TFC	Total Final Consumption
TPES	Total Primary Energy Supply

Appendix B: Conversions

Conversion to Standard International units

1 barrel (petroleum, 42 gallons)	= 0.1589873 m^3
1 Btu (British thermal unit)	= 1,055 J
1 calorie (thermochemical)	= 4.184 J
1 foot	= 0.3048 m
1 gallon (UK, liquid)	= 4.546087 * 10^{-3} m^3
1 gallon (U.S., liquid)	= 3.785411784 * 10^{-3} m^3
1 hectare	= 10,000 m^2
1 horsepower (metric)	= 736 W
1 inch	= 0.0254 m
1 mile (U.S. statute)	= 1,609.344 m
1 ton (long)	= 1,016.0469 kg
1 ton (metric)	= 1,000 kg
1 ton (short)	= 907.18474 kg

Table B.1: Conversion for common energy units

		J	tce	toe	m^3 NG*	GWh
1 J	=	1	34.14 E-12	22.34 E-12	26.84 E-9	277.8 E-15
1 tce	=	29.29 E+9	1	0.6543	786.1	8.135 E-6
1 toe	=	44.76	1.528	1	1201	12.43E-2
1 m^3 NG*	=	37.26 E+6	1272 E-6	832.3E-6	1	10.35 E-6
1 GWh	=	3.60 E+12	122.8	80.42	96.62	1

* Natural Gas (NG)

k	: kilo	= 10^3
M	: Mega	= 10^6
G	: Giga	= 10^9
T	: Tera	= 10^{12}
P	: Peta	= 10^{15}

Appendix C: End-use electricity consumption in the residential sector breakdown by appliances.

Table C.1: End-use electricity consumption in the residential sector breakdown by appliances[a]

End-use categories → Household appl. ↓	Pu	Ve	Re	OM	Li	El	SC	HL	HH	Mi	Tot
Refrigerator:			100								100
Freezer:			100								100
Refrigerator/freezer:			100								100
Washing machine:	5			20				75			100
Dishwasher:	5			20				75			100
Clothes drier:		5		20				75			100
Electric cooker:									100		100
Heat distribut.:	70	30									100
Ventilation:		100									100
Lighting:					100						100
Electronics:						100					100
Space cooling:		5	95								100
Space heating:								100			100
Elec. hot water:								100			100
Miscellaneous:				50		25				25	100
All End-uses:	4	2	20	5	14	4	0	34	17	1	100

[a] Country: Denmark 1990, all data in percentages [Source: Nørgård, 1992: p. 35]

Appendix D: Electricity saving potentials according to Nørgård.

A correct interpretation of the results presented in this simulation study requires information concerning details of the electricity saving potentials that are assumed for the year 2010. These data are derived from data compiled by Nørgård [Nørgård, 1992], and are not corrected for the differences between OECD Europe countries.

General:	
- Pumping:	reduced need for pumping, reduced friction and better pumps and motors 55%-48%
- Ventilation:	Reduce need for air flow, fan and motor improvements 57%-30%
- Refrigeration:	more thermal insulation, better heat exchangers, better compressors 77%-14%
- Other Motors:	variable output control, better motors 87%-56%
- Lighting:	reduced need for artificial lighting, improve light fixture efficiency, light sources, control systems 50%-20%
- Electronics:	less power required for standby and remote control, computers, copiers and laser printers 70%-20%
- Space Cooling:	building design and retrofitting, refrigeration system improvement 25%
- Low Temp. Heat:	better building envelopes; free heat loss 100%-28%
- High Temp. Heat:	91%-56%
- Miscellaneous:	83%-60%
Household appliances:	
- Refrigerator:	14%
- Freezer:	20%
- Refrigerator/freezer:	20%
- Washing Machine:	30%
- Dishwasher:	33%
- Clothes Drier:	35%
- Electric Cooker:	35%
- Heat Distribution:	13%
- Ventilation:	15%
- Lighting:	20%
- Electronic:	25%
- Space Cooling:	25%
- Space Heating:	25%

- Hot Water: 35%
- Miscellaneous: 50%

All data represent the percentages of electricity still needed for a certain appliance or category of appliances in the reference year compared to the base year (=100%).

Appendix E: Load curves used by the IEEE "test" system

The combination of 52 weekly peak loads (*Figure E.1*), 7 daily peak loads and 24 hourly peak loads, all as fractions, in combination with the annual peak load, results in an hourly load model for a year consisting of 8736 hours, cf. *Formula (E.1)*. Instead of 1 day (with 24 hours), 6 days spread over the year are defined to overcome seasonal differences. The second week of the year, constructed as described above is shown in *Figure E.2*.

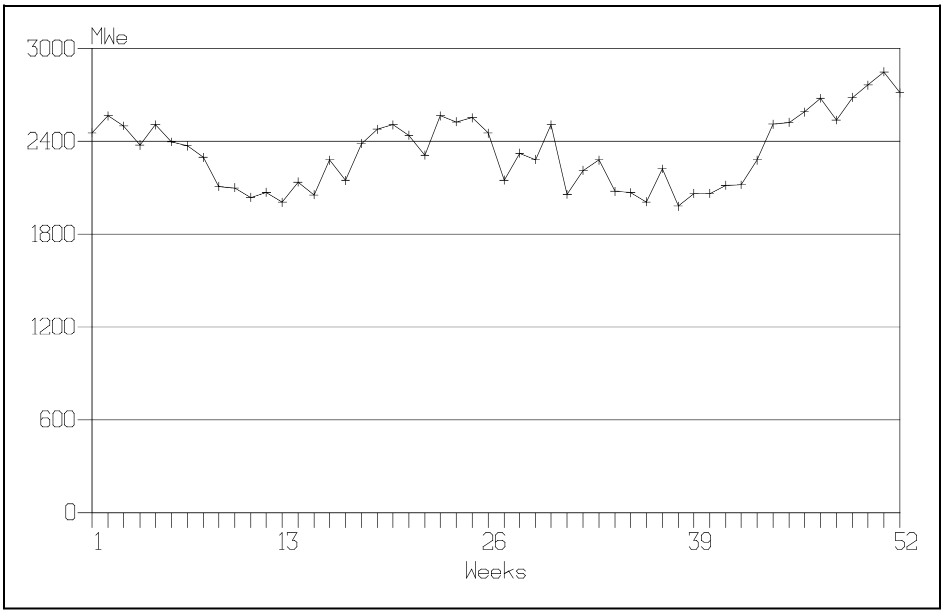


Figure E.1: Weekly peak loads for a full year [IEEE, 1979].

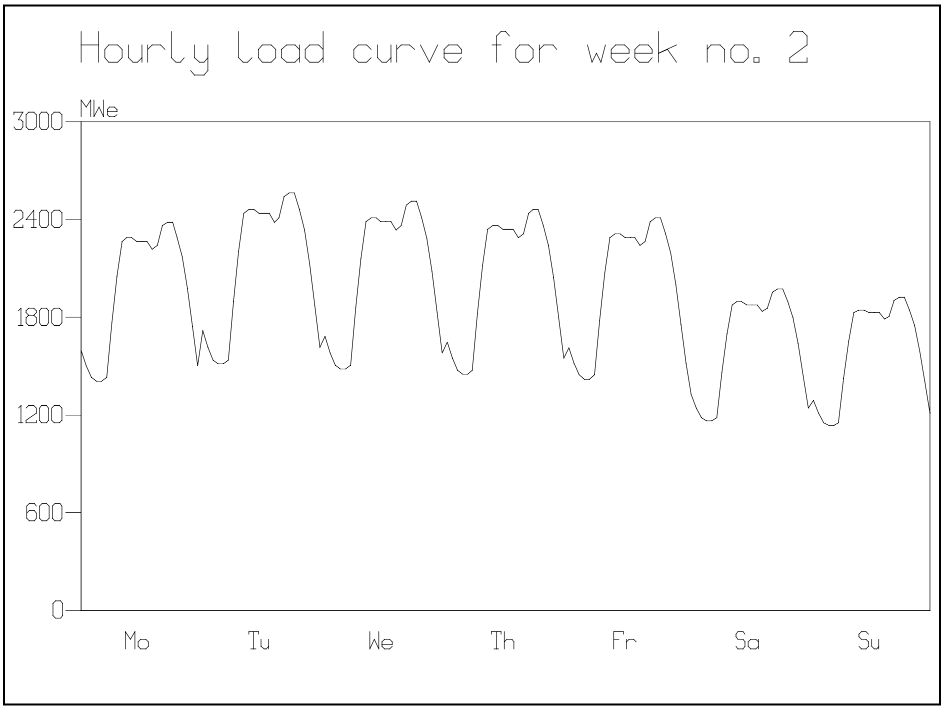


Figure E.2: Hourly load curve for week no. 2.

$$ED_i = FrW_j * FrD_k * FrH_l * PL \qquad \textbf{(E.1)}$$

Where:	ED	=	Electricity Demand per hour
	FrW	=	Weekly peak loads as a Fraction
	FrD	=	Daily peak loads as a Fraction
	FrH	=	Hourly peak loads as a Fraction
	PL	=	Peak Load (2850 MW)
	j	=	number of weeks in a year: 1..52
	k	=	number of days in a week: 1..7
	l	=	number of hours per day: 1..24
	i	=	number of hours in this IEEE "test" year: j*k*l (1..8736)

In *Figure E.3* the resulting Load Duration Curve calculated from the three sets of peak load fraction and the annual peak load is shown.

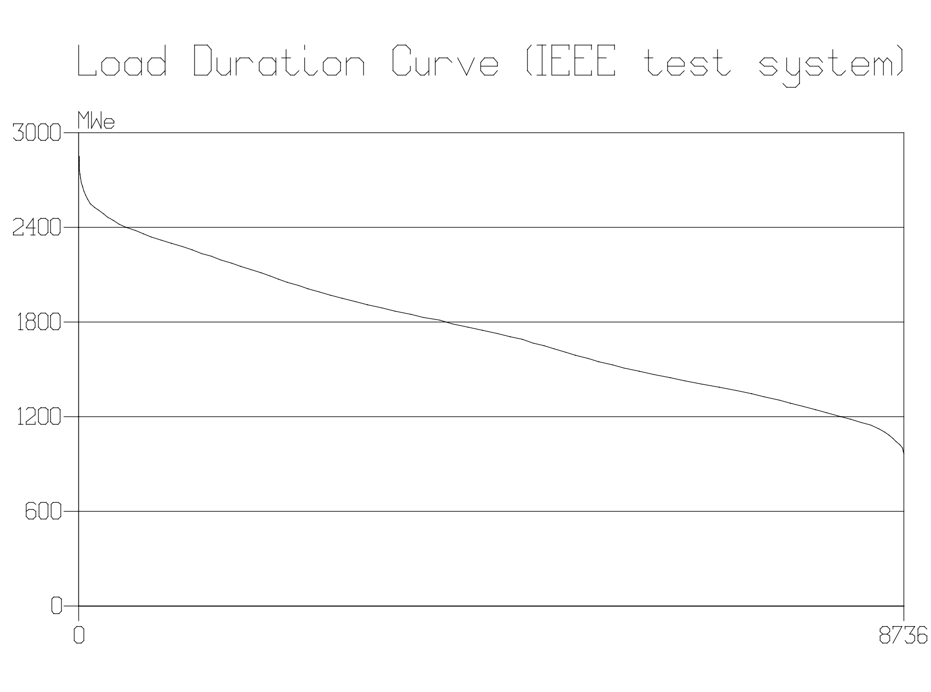


Figure E.3 Annual Load Duration Curve as defined by the three sets of peak loads (Weekly, Daily and Hourly) and subsequently sorted [IEEE, 1979].

The points describing the LDC used in PowerPlan for comparison with the data obtained from the "exact" method as described in section 7.2 are derived from the LDC shown in *Figure E.3*.
The points N_j are derived as follows:

$$N_0 = ED_1 \,/\, PL \tag{E.2}$$

$$N_j = ED_{Round\,(8736 * \frac{j}{n})} \;/\; PL \qquad \textbf{(E.3)}$$

$$N_n = ED_{8736} \;/\; PL \qquad \textbf{(E.4)}$$

Where:	N	=	Fraction of the peak load at a certain point on the LDC used in PowerPlan
	j	=	Points which define the LDC in PowerPlan: 0..n (n = 10, 25, 50, 100 or 250)
	ED_i	=	Electricity Demand in hour i (1..8736)
	PL	=	Peak Load (2850 MW)

Appendix F: "Exact" method to calculate the IEEE "test" system

For the "exact" results obtained from the IEEE test system, a Monte Carlo method for the computation of generating system reliability indices has been used [Rubinstein, 1981]. For each hour of the 8736 (52*7*24) hours present in the test LDC the demand for electricity is met with capacity according to the merit order as described in chapter 7. For each unit there is a pseudo random possibility of unplanned outage of 1/(MTTF+MTTR), see *Table F.1*. The time needed for the repair when a unplanned outage occurs is given in column MTTR.

Table F.1: Generating unit reliability data.

Units	Unit size (MWe)	Forced Outage rate[3]	MTTF[1] (hrs.)	MTTR[2] (hrs.)
Nuclear	400	0.12	1100	150
Coal-1	350	0.08	1150	100
Oil-1	197	0.05	950	50
Coal-2	155	0.04	960	40
Oil-2	100	0.04	1200	50
Coal-3	76	0.02	1960	40
Oil-3	12	0.02	2940	60
Hydro	50	0.01	1980	20
Comb.T	20	0.10	450	50

1 MTTF = Mean Time To Failure
2 MTTR = Mean Time To Repair
3 Forced outage rate = MTTR / (MTTF + MTTR)

For each yearly hour the electricity generated, the loss of load probability and the expected unserved electricity is calculated. To reduce probability bias, a Monte Carlo simulation is used.

Appendix G: Merit order for SEPU and PowerPlan

Table G.1: PowerPlan*

Unit type
Dec: Wind
Dec: Hydro
Dec: PV
Dec: ST Continue
Dec: GT Continue
Dec: Gasturbine
Dec: Gas Motor
Dec: District heating
Dec: Public waste
Cen: Import
Cen: Nuclear
Cen: CHP
Cen: STAG NG
Cen: STAG CG
Cen: Coal new
Cen: Coal
Cen: STAG
Cen: Conv. O/G
Cen: GT Peak

* The unit types in the SEPU table are sometimes aggregated to get comparable names as used in the PowerPlan table. The aggregation does not affect the merit order substantially.

Table G.2: SEPU*

Unit type	Load	Capacity restriction
Nuclear	min	
Import	min+100	> 310
Wind	100	
Hydro	100	
Photo Voltaic	100	
Dec. District Heating	following	
Public waste	following	
ST Continue	following	
GT Continu	following	
Gasturbine	following	
Gas Motor	following	
Nuclear	100	
CHP centr.	following	
STAG NG	min	
STAG CG	min	> 300
Import	min	< 310
Coal new	min	
STAG NG	100	
STAG CG	100	> 300
Import	100	< 310
Coal new	100	
Coal	min	> 519
Coal	100	> 519
Coal	min+100	< 519
STAG CG	min+100	< 300
STAG	min+100	
Conv O/G	min+100	
CHP centr.	100	
Dec. District Heating	100	
Public waste	100	
ST Continue	100	
GT Continue	100	
Gasturbine	100	
Gas Motor	100	

* see note at the PowerPlan table.

Appendix H: How to use the MEED model

This appendix is not intended as a very detailed and comprehensive description of the user interface of the MEED model. However the major options will be shown by means of screen dumps of the user interface. A brief description at each screen dump explains that specific screen and gives an impression how to use the model.
Figure H.1 shows a flow chart of the user interface.

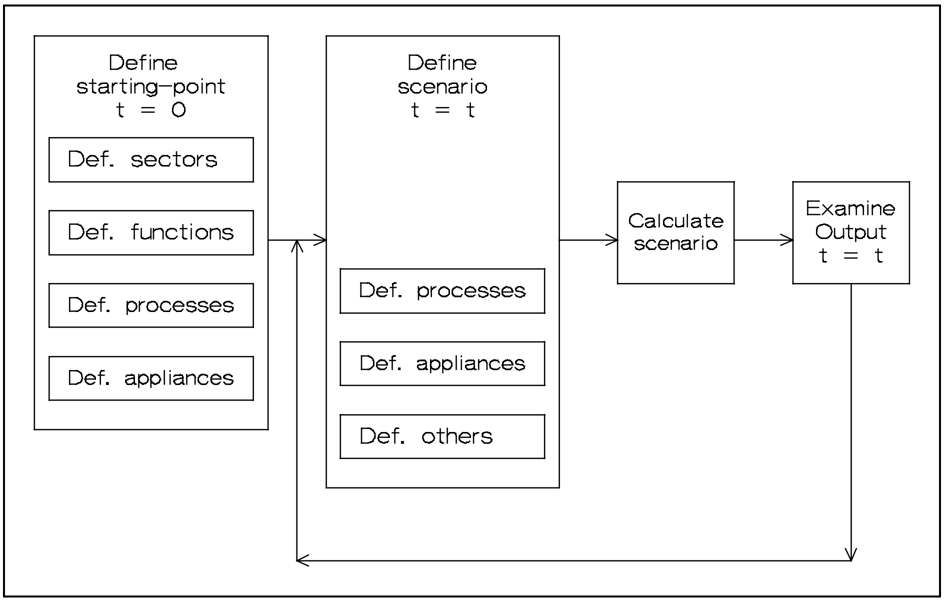
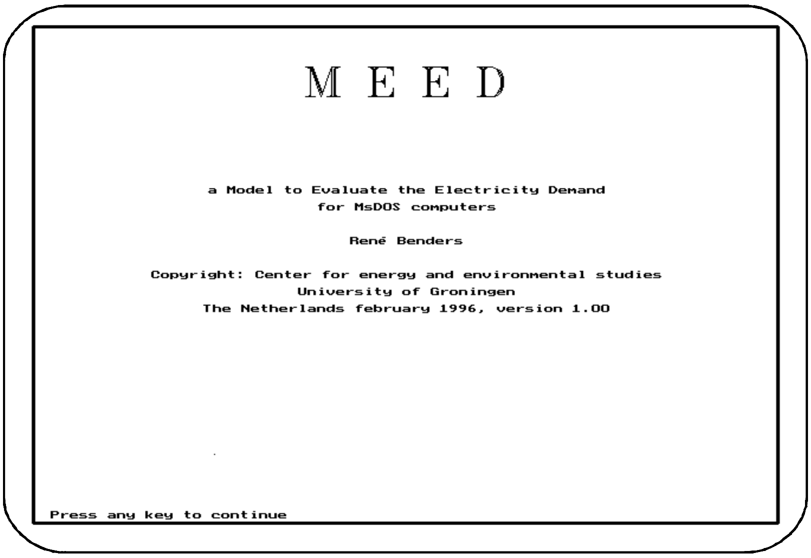
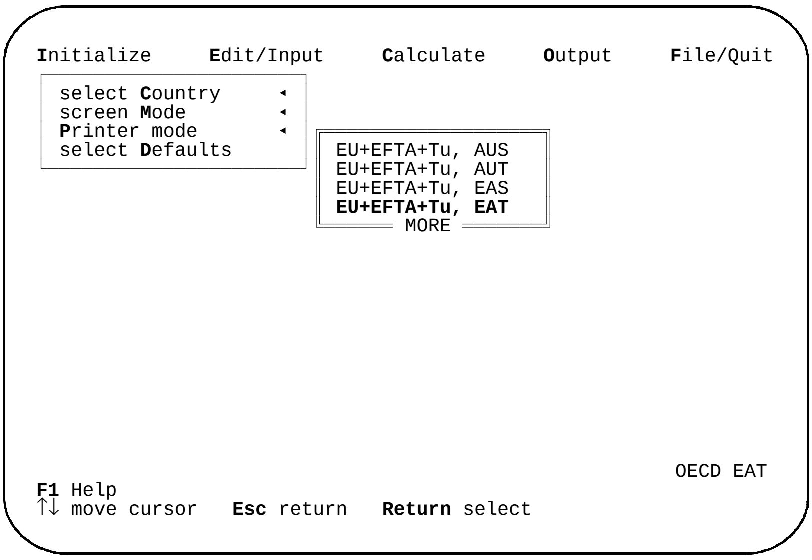


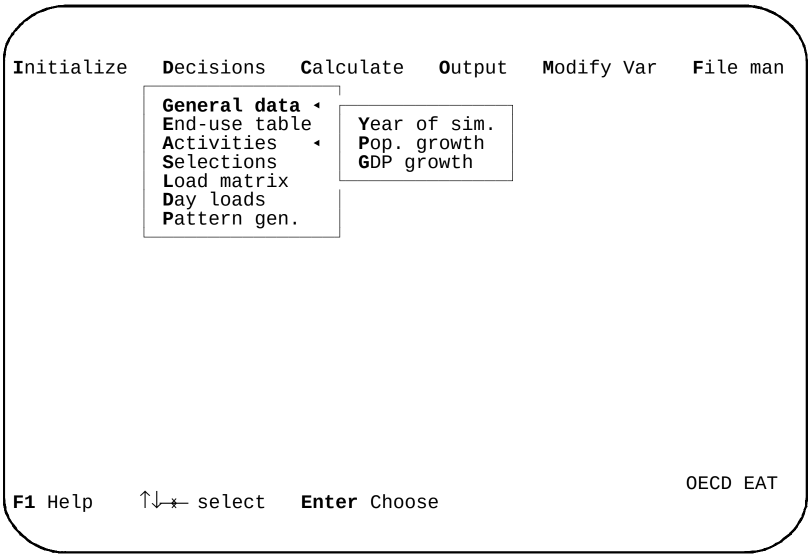
Figure H.1: Structure of the user interface of the MEED software.



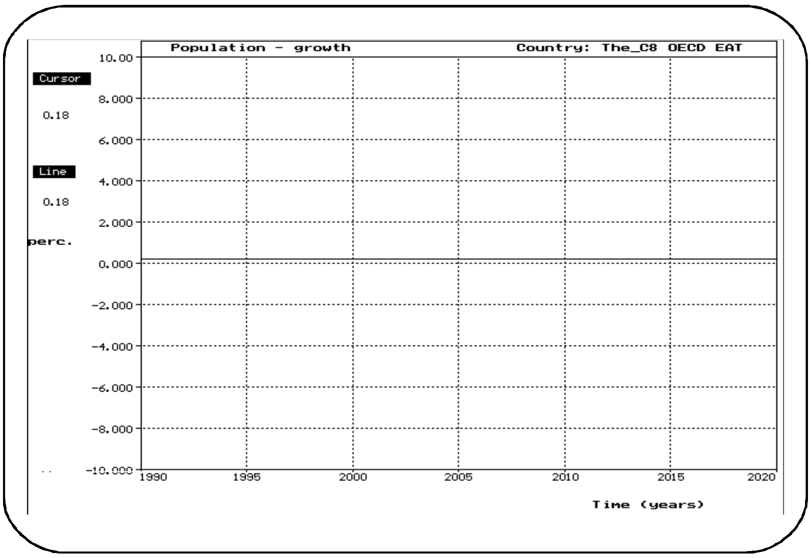
Screen 1: Introductory screen of the demand model MEED.



Screen 2: To Simulate the electricity demand of a country, one should first load the initial data (e.g. present sectors, functions and technologies) and default scenario variables (e.g. GDP growth).



Screen 3: First general input data can be viewed and/or adjusted.



Screen 4: In this screen: "**Pop. growth**", the time-series of the population growth can be examined and/or adjusted.

End-use matrix (in PJ Useful energy) Country: OECD EAT

	Total	Pump.	Vent.	**Refri.**	O. mot.	Light	Electr
Industry	1355.0	127.02	163.58	92.37	673.56	161.66	15.40
Transport	56.76	0.00	0.00	0.00	19.43	19.78	0.00
Agriculture	32.23	6.72	4.58	1.70	14.42	2.80	0.18
Commerce	430.27	54.10	81.15	48.69	43.28	115.05	11.90
Residential	644.11	20.83	10.68	**41.11**	27.43	34.56	12.25
Total energy	2518.4	208.66	259.99	183.87	778.12	333.84	39.73

↑↓→← move cursor **F4** edit techn. **F5** show graphs **F6** edit process
F8 activities **F9** change matrix **F10** selections

Screen 5: This screen: "**End-use table**", shows the core of the model. From here scenarios (technology improvements, shifts and process improvements, shifts) can be defined.

Function: Refrigeration Sector: Residential

Basic year: 1990

Name	Frac	Eff	EL	TL	FC	O&M	FYr	LYr	PN
Av. refrigerator	**0.280**	**0.100**	**10**	**16**	**2000**	**0.02**	**1990**	**2050**	**2**
Av. deep freezer	0.470	0.100	8	12	2000	0.02	1990	2050	2
fridge/freezer	0.250	0.100	9	16	2500	0.02	1990	2050	2

Reference year: 2020

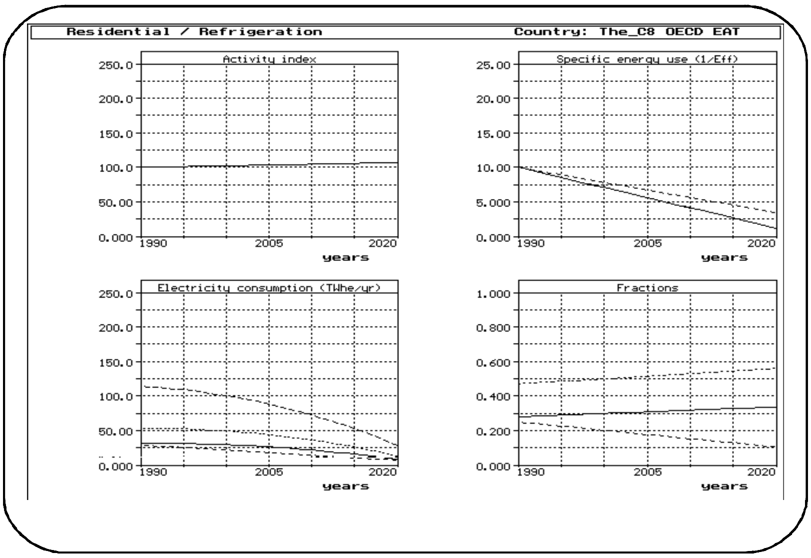
Name	Frac	Eff	EL	TL	FC	O&M	FYr	LYr	PN
Av. refrigerator	**0.337**	**0.830**	**10**	**16**	**3930**	**0.02**	**1990**	**2050**	**2**
Av. deep freezer	0.558	0.820	8	12	2740	0.02	1990	2050	2
fridge/freezer	0.105	0.290	9	16	2600	0.02	1990	2050	2

F1 help ↑↓ move cursor **Ctrl**→← scroll window **PgDn** select window
Return edit **Ins** insert techn. **Del** remove techn. **F2** rescale

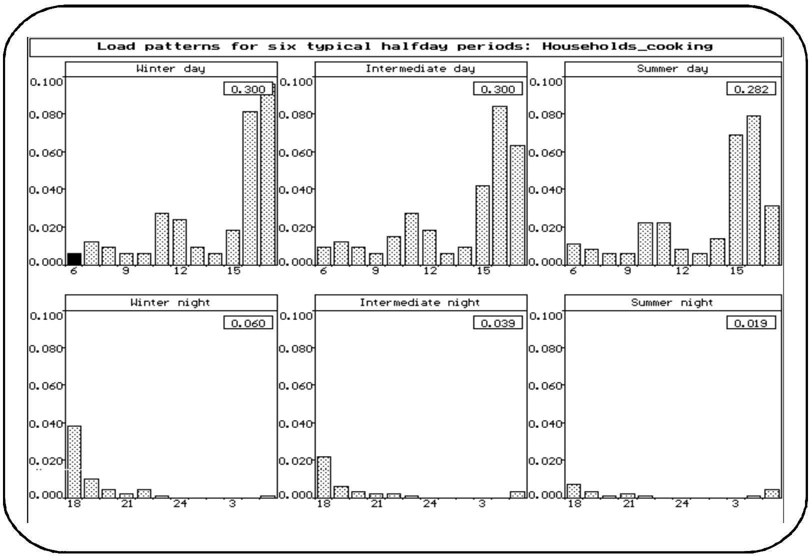
Screen 6: In this screen: "**F4 edit techn.**", technologies on a matrix element level can be adjusted (cf. *Screen 5*).

```
Sector: Residential
  Basic year: 1990
Name                  EUse Frac InFr   Pu   Ve   Re   OM   Li   El

Housing North       228.00 0.05 0.05 2.00 1.00 9.00 3.00 7.00 2.00
Housing Middle      100.00 0.42 0.42 4.00 2.00 17.0 5.00 13.0 4.00
Housing South        68.00 0.53 0.53 4.00 2.00 21.0 6.00 16.0 4.00


  Reference year: 2020
Name                  EUse Frac InFr   Pu   Ve   Re   OM   Li   El

Housing North       247.00 0.05 0.05 3.00 1.00 12.0 3.00 8.00 3.00
Housing Middle      133.00 0.42 0.42 4.00 2.00 21.0 6.00 15.0 4.00
Housing South       107.00 0.53 0.53 5.00 2.00 21.0 6.00 16.0 5.00


F1 help   ↑↓ move cursor  Ctrl←→ scroll window  PgDn select window
Return edit   Ins insert process   Del remove process   F2 rescale
```

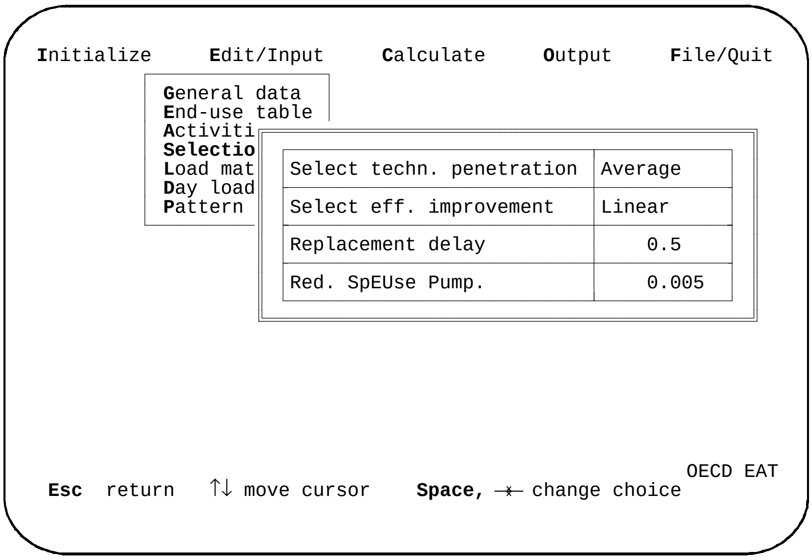
Screen 7: In this screen: "**F6 edit process**", sectoral processes can be adjusted (cf. *Screen 5*).



Screen 8: In this screen: "**F5 show graphs**", the development of the electricity use, per technology in a selected end-use matrix element can be viewed for four essential variables (cf. *Screen 5*).



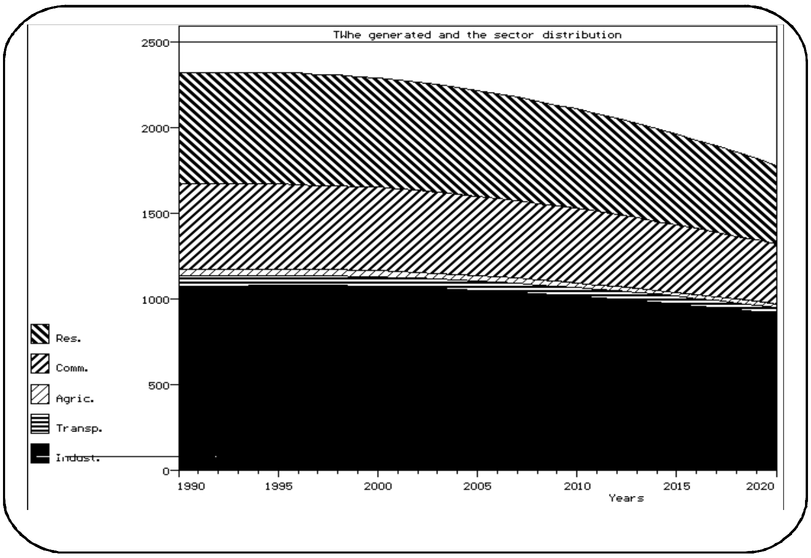
Screen 9: In this screen: "**Day loads**", an example of a typical pattern for cooking in the residential sector is shown. Each bar represents one hour (of the 72 defined). The data are normalized to one.



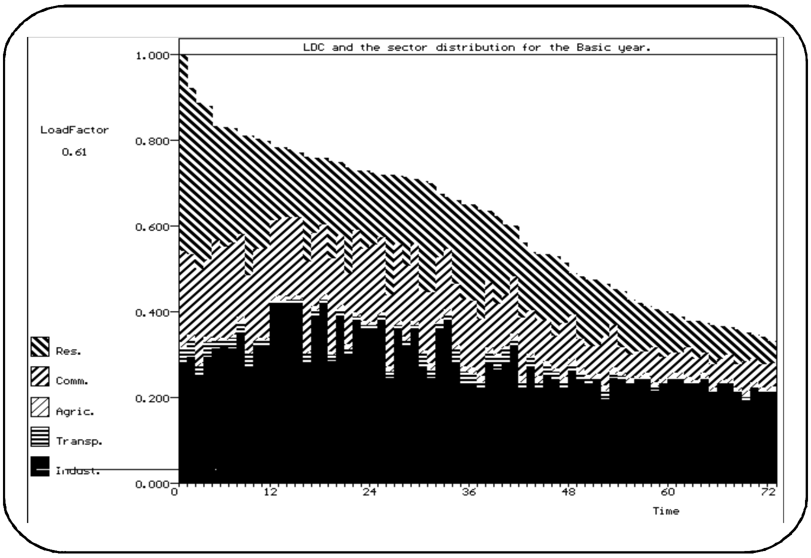
Screen 10: In this screen: "**Selections**", the user can select how efficiencies improvements develop over time and how new technologies penetrate the market.

```
Initialize     Edit/Input     Calculate     Output     File/Quit
                                           El. dem. sec.
                                           el. dem. Func.
                                           LDC Curve
                                           Sankey diagram
                                           Patterns
                                           Detailed output ◂

                                                        OECD EAT
  F1 Help   ↑↓ select   Enter Choose
```

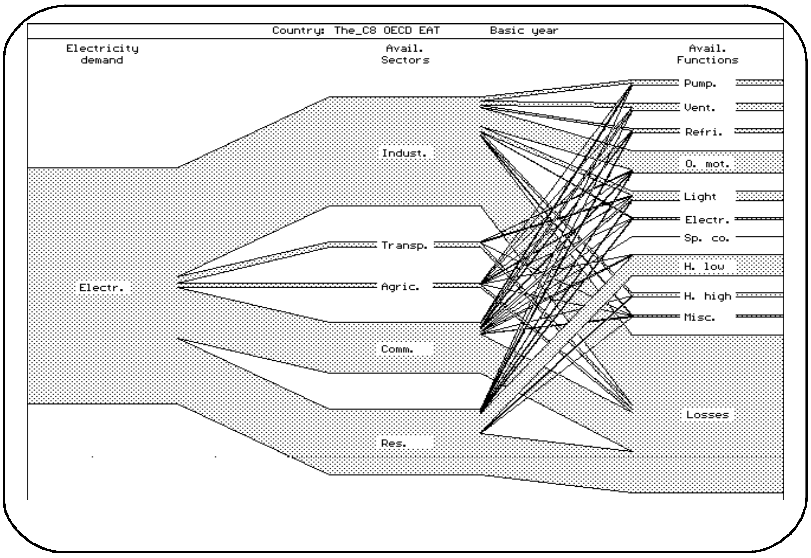
Screen 11: The next step is to "**Calculate**" the scenario as defined in the "**Edit/Input**" sub-menu and then view the simulation results in the "**Output**" sub-menu.



Screen 12: This screen: "**El. dem. sec.**", shows the electricity demand per sector. Not shown is the electricity demand per function (**el. dem. Func.**).



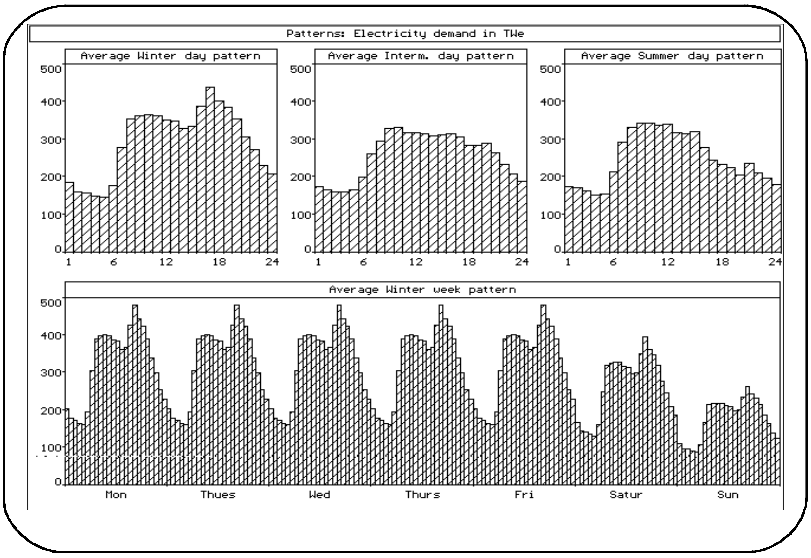
Screen 13: This screen: "**LDC curve**", shows the LDC in the base year. The LDC of the reference year and some intermediate years can be viewed as well.



Screen 14: This screen: "**Sankey diagram**", shows an overview of the electricity use. The item "**Losses**" is a measure for the inefficiency. A diagram for the reference year is also present.

```
Detailed output country:  OECD EAT                Line:  19 of  95

Country : OECD EAT
Comment : OECD Europe for PP/MEED, Consumption is bruto
Date    : 28 February 1996
Time    : 14:42:56

Sectoral activity intensities and other general data

Variable           Unit          Values
year                               1990      2005      2020

Population           Millions    371.00    381.14    391.57
GNP                    MU/cap     15490     22324     30942

Industry           E.I. index    100.00     78.44     54.19
Transport          E.I. index    100.00     77.83     54.17
Agriculture        E.I. index    100.00     68.26     35.06
Commerce           E.I. index    100.00     72.90     42.74
Residential        E.I. index    100.00     92.03     66.54

↑↓,PgUp,PgDn move cursor   Esc previous screen
```

Screen 15: This screen: "**Detailed output**", shows a part of the detailed simulation results.



Screen 16: In this screen: "**Patterns**", the three day patterns are shown as well as a constructed winter week pattern. A constructed year pattern can also be viewed.

Appendix I: How to use the PowerPlan model

This appendix is intended as an introduction to the user interface of PowerPlan and a brief description on 'how to use' the model. The major options will be shown by means of screen dumps of the interface.
Figure I.1 shows a flow chart of the user interface.

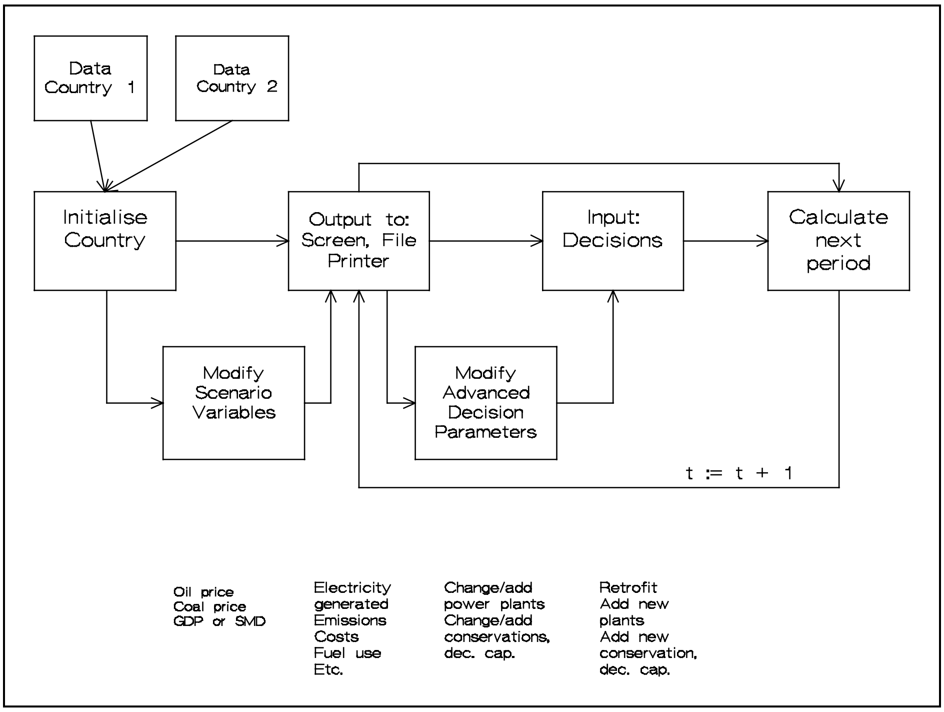
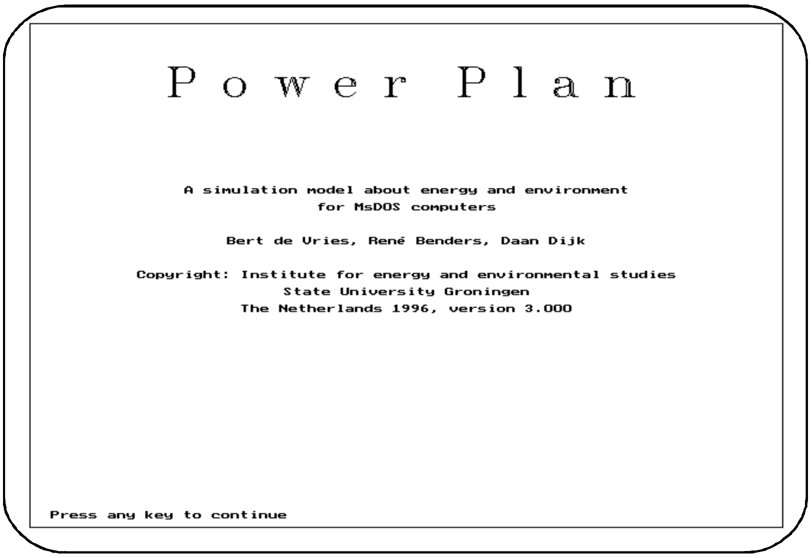
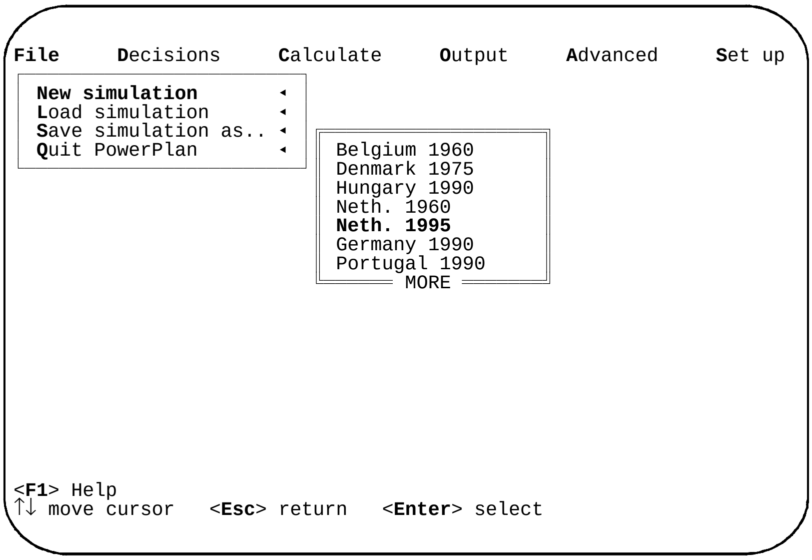


Figure I.1: Structure of the user interface of the PowerPlan software.

The main sequence in the model use is: initialise, output, input, calculate and back to output again. The two other options are for more experienced users. All default values and initial data are read from a Country data file.
The screen dumps on the following pages are ordered along the lines of *Figure I.1*: initialize, view output, make decisions and for the experienced users: set up scenario and advanced options.



Screen 1: Introduction screen of the interactive computer simulation model PowerPlan.



Screen 2: To simulate the electricity production of a country, one should first load the initial data (e.g. present power plants) and default scenario variables (e.g. GDP growth, Oil price path).

File **D**ecisions **C**alculate **Output** **A**dvanced **S**et up

Screen
Printer
File

Generation
costs/**F**uels/env
Environment
c**O**sts (g)
fuels (**G**)
Planning
power **C**apacity
Dem reduction

<**F1**> Help ↓↑ move cursor <**Enter**> select **Neth 1995**

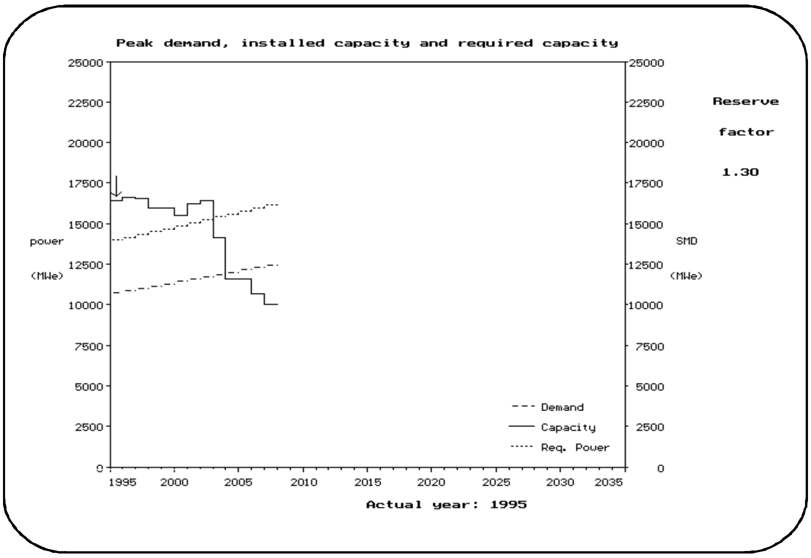
Screen 3: First the output of the starting year can be viewed. This output is the basis for further decisions to be made for the desired scenario.

Output: Electricity **generated** Year: **1995**

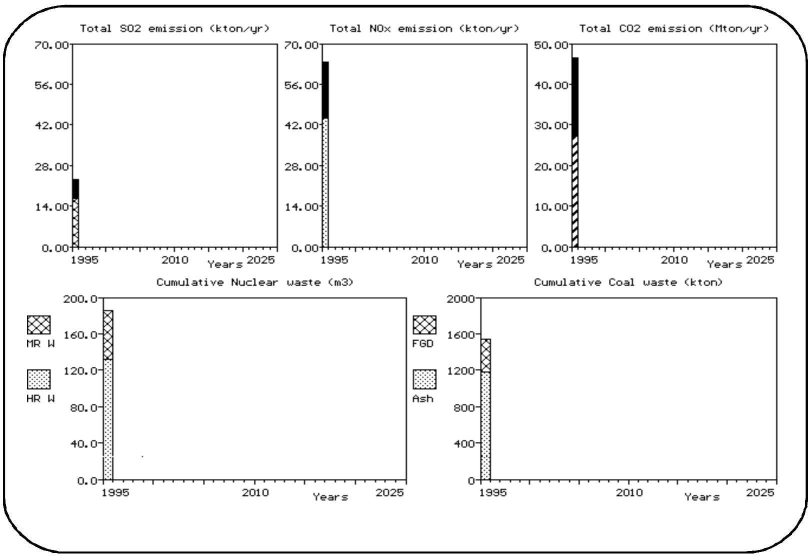
Power station	Electr. (TWhe)	Cap. (MWe)	LF (Hrs)	Eff. (%)	Fuel (PJ)	SO2-em (kton)	NOx-em (kton)	Costs fl/kWhe
Import	6.132	700	8760	0.0	0.00	0.00	0.00	0.100
Nuclear	3.437	521	6597	0.0	36.39	0.00	0.00	0.017
CHP	7.695	1575	4887	47.9	58.51	0.00	4.85	0.101
STAG NG	6.806	1005	6772	50.0	49.00	0.00	2.21	0.104
STAG CG	1.475	225	6556	43.0	12.35	0.36	0.99	0.075
Coal new	7.335	1200	6112	41.5	63.61	3.70	1.27	0.078
Coal	12.843	2909	4414	39.6	116.86	12.09	22.22	0.092
STAG	0.370	121	3055	43.0	3.10	0.00	0.54	0.119
Conv. O/G	12.254	7860	1559	42.1	105.04	0.56	12.24	0.152
GT Peak	0.001	315	5	25.0	0.02	0.00	0.00	3.406
Total	58.348	16432	3551	43.4	444.89	16.71	44.32	0.107

Peak demand (SMD)	:	10757	(MWe)
Reserve factor	:	1.53	
Expected Unserved Electricity (EUE)	:	1.0	(GWhe)
Loss Of Load Probability (LOLP)	:	0.6	(days/10 years)

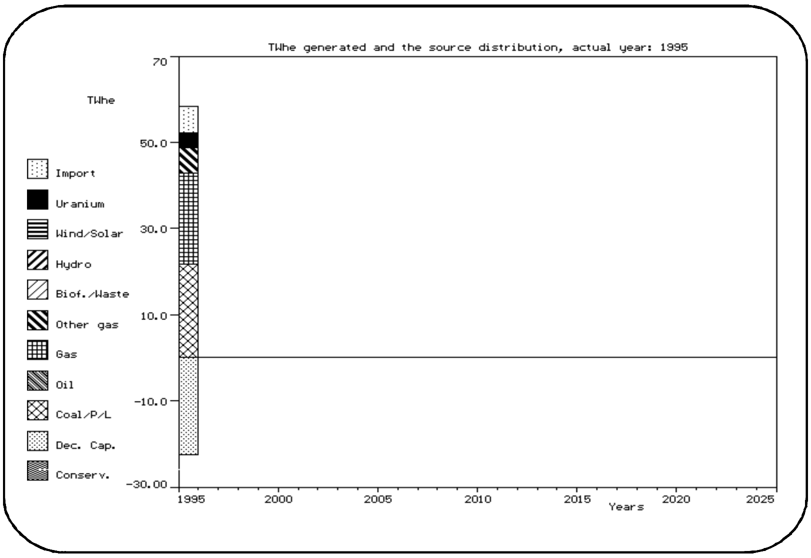
Screen 4: The detailed performance of the present electricity production system is presented in the "**Generation**" screen.



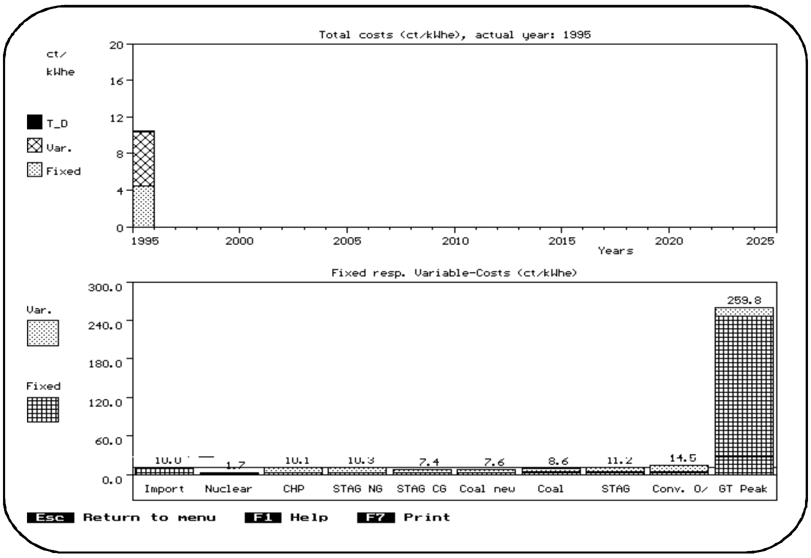
Screen 5: In the "**Planning**" graph a *prognosis* is shown of the future electricity demand, the capacity required for a reliable electricity production system and the capacity installed.



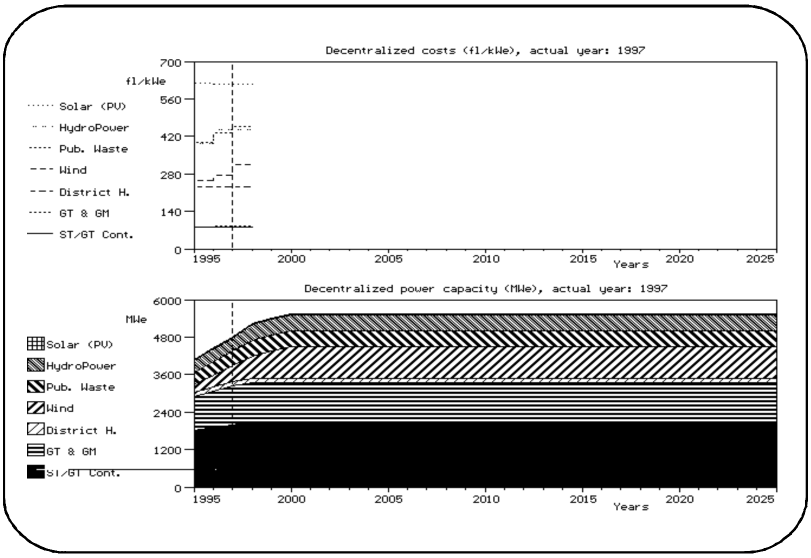
Screen 6: In this screen: "**Environment**", the five major pollutants from the electricity generating system are presented. The solid waste data concern cumulative figures.



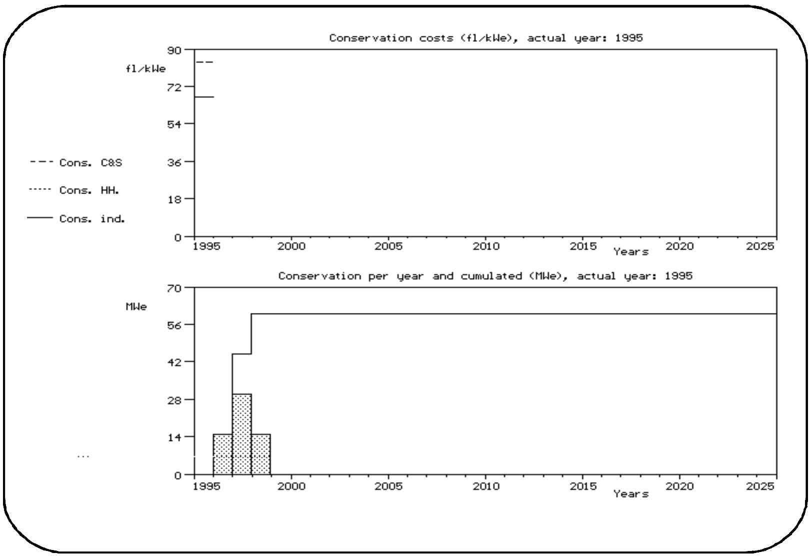
Screen 7: In this screen: "**fuels (G)**", the fuel mix of the electricity system is shown. Conservation and decentral capacity are presented as negative generated electricity.



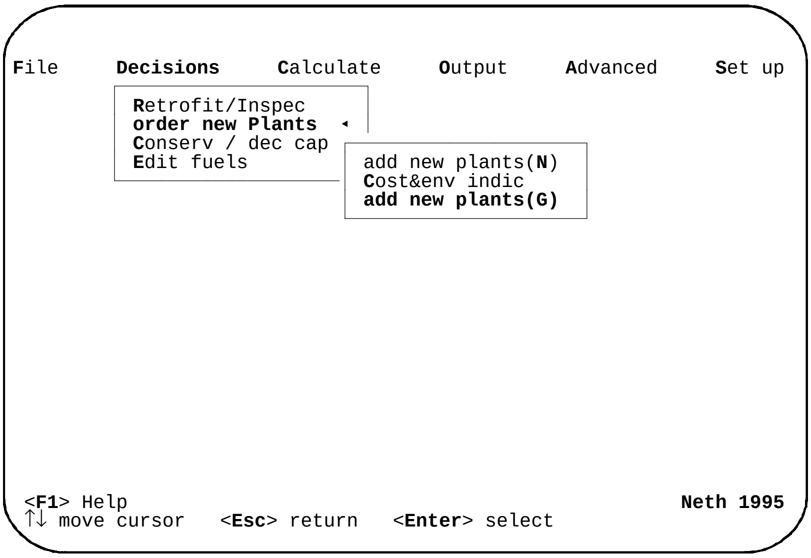
Screen 8: This screen: "**cOsts (g)**, shows the overall production costs per kWhe in the upper graph and the production costs per type of power station in the lower graph.



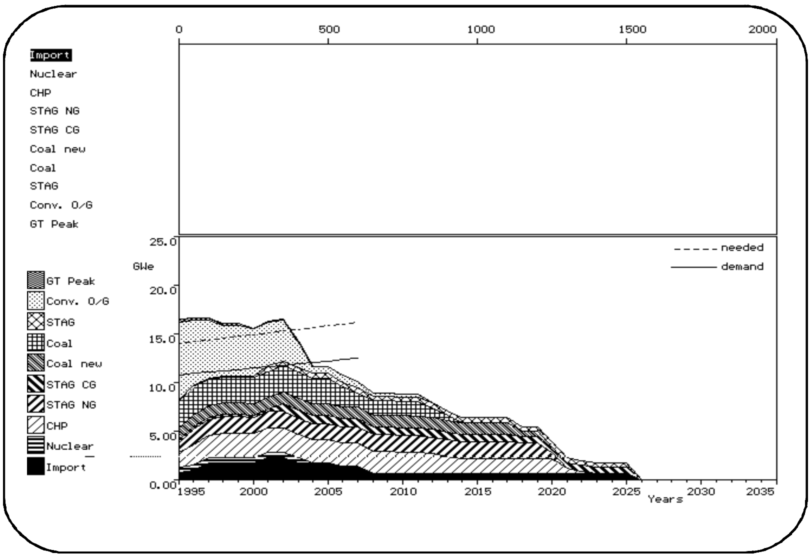
Screen 9: In this screen: "**Dem reduction**", the installed decentral capacity (lower graph) and the costs per kWe (upper graph) are shown. The costs depend on the marginal costs (cf. *Screen 24*).



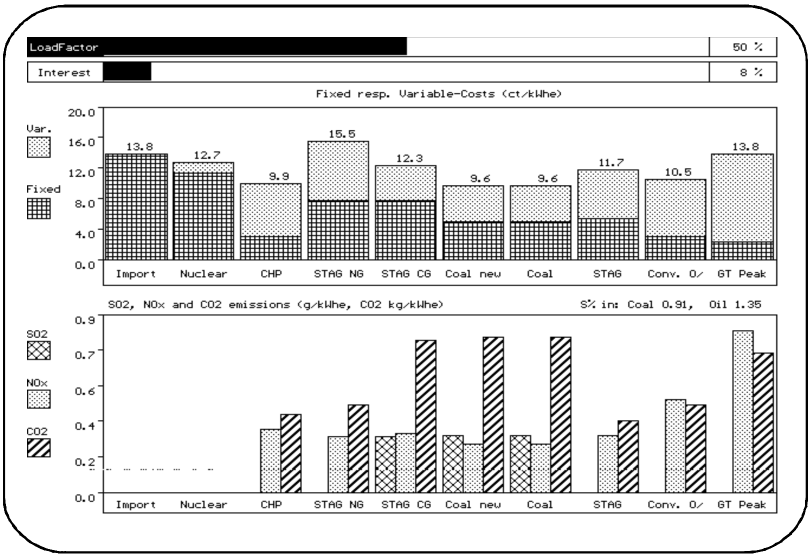
Screen 10: In this screen: "**Dem reduction**", the installed conservation cap. (per year: bars, cumulative: line) and the costs per kWhe are shown. The costs depend on the marginal costs (cf. *Screen 24*).



Screen 11: The next step is to make your decisions, based on the output data. New power stations can be built graphically (cf. *Screen 12*) or numerically (cf. *Screen 14*).



Screen 12: In this screen: "**add new plants (G)**", power stations can be built on a "back of an envelope" manner. The result of building a power station can be viewed directly in the capacity graph.



Screen 13: In this screen: "**Cost&env indic**", power stations can be compared in terms of their costs and their environmental impact (gaseous emissions), for a load factor chosen and interest rate.

Input-screen: order new power plants actual year: 1995

Pow. typ.	EL	TL	CT	Cap	FT	FiCo	Ma Co	LT	Eff.	SO2	NOx	Num	MWe
Import	10	10	3	50	I	4000	0.002	B				0	0
Import	10	10	3	50	I	4000	0.002	B				0	0
Nuclear	20	25	9	900	U	4850	0.012	B				0	0
CHP	20	25	4	10	G	1200	0.014	B	0.50	0.00	45	0	0
CHP	20	25	4	25	G	1300	0.010	B	0.50	0.00	45	0	0
STAG NG	20	25	6	600	G	3300	0.013	B	0.45	0.95	36	0	0
STAG CG	20	25	6	600	C	3300	0.013	B	0.43	0.95	36	0	0
Coal new	20	25	6	600	C	2100	0.013	B	0.42	0.95	29	0	0

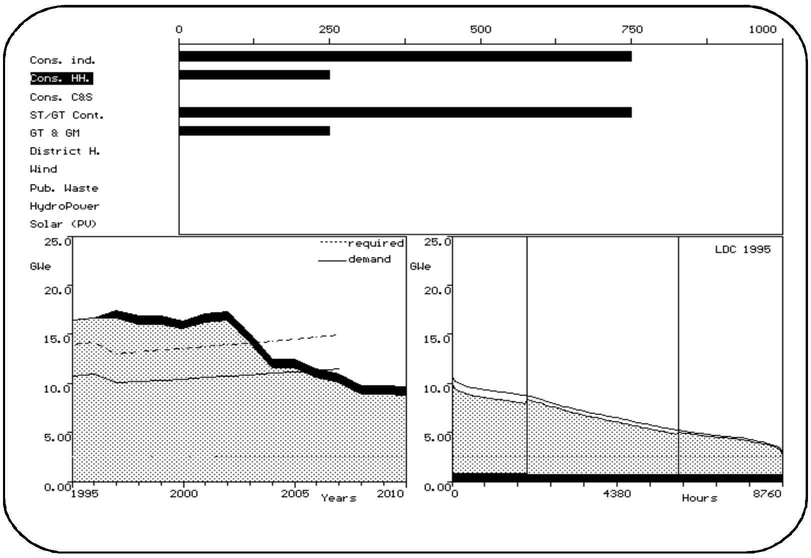
Total capacity ordered (MWe) 0

↑↓ move cursor <**Esc**> return to menu
For additional types see Modify (Add offers).

Screen 14: In this screen: "**add new plant (N)**," the user can order new power plants. Characteristics of the present power plants are showed here, in contrast to *Screen 12*.

```
File     Decisions     Calculate     Output     Advanced     Set up

         Retrofit/Inspec
         order new Plants  ◂
         Conserv / dec cap
         Edit fuels           add cons&decc (N)
                              Cost indicators
                              add cons&decc (G)

 <F1> Help                                                Neth 1995
 ↑↓ move cursor   <Esc> return   <Enter> select
```

Screen 15: In this sub-menu conservation measures and decentral capacity can be ordered. Only "**add cons&decc (G)**" is shown here (cf. *Screen 16*); the others are treated like the central capacity.



Screen 16: In this screen: "**add cons&dec (G)**," new orders can be placed. The left panel shows the effect on the installed capacity and the peak demand while the right panel shows its effect on the LDC.

```
File      Decisions     Calculate     Output     Advanced    Set up

          Retrofit/Inspec
          order new Plants  ◂
          Conserv / dec cap
          Edit fuels
                             Coal
                             Oil
                             nat. Gas
                             Uranium
                             Lignite
                             MSW
                             Biofuel
                             Peat
                             oTher gas

 <F1> Help                                                  Neth 1995
 ↑↓ move cursor    <Esc> return    <Enter> select
```

Screen 17: Fuel characteristics are not coupled to power plants directly (e.g. SO_2 emission in g/GJ) but are present in the form of large contracts (e.g. S contents in %) which can change each year.

```
Edit - Fuel price, fraction use & pollutants      actual year: 1995
```

Fuel Grades	Price fl/tce	Frac. of RG price	Frac. Use	Heat rate GJ/tce	Sulphur Content %	Ash Cont. %
Coal RG	107.00	1.00	0.38	26.90	1.25	11.00
Coal A	107.00	1.00	0.35	26.90	0.70	11.00
Coal B	107.00	1.00	0.08	26.90	0.95	11.00
Coal C	107.00	1.00	0.20	26.90	0.65	11.00

```
<Esc> to menu   <Tab>, <Shift>-<Tab> change column   ↓↑ change row
```

Screen 18: In this screen, an example is given of a fuel contracts as described in *Screen 17*. Four types of fuel with their specific characteristics can be selected in a certain combination.

File **Decisions** **C**alculate **O**utput **A**dvanced **S**et up

Retrofit/Inspec
order new **P**lants
Conserv / dec cap
Edit fuels

<**F1**> Help **Neth 1995**
↑↓ move cursor <**Esc**> return <**Enter**> select

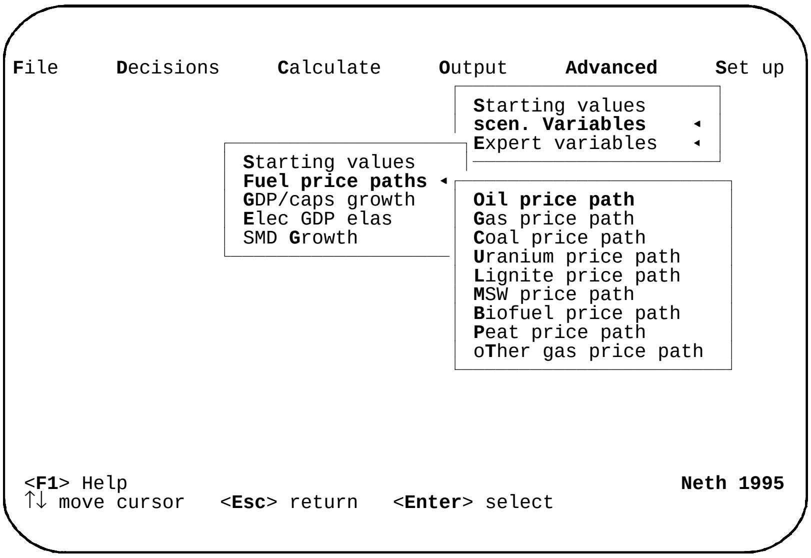
Screen 19: Retrofit options (e.g. life-time extension of a power plant or ad FGD cleaning equipment to an existing power plant) are also an option for the user.

Edit-screen: retrofit existing power stations actual year: 1995

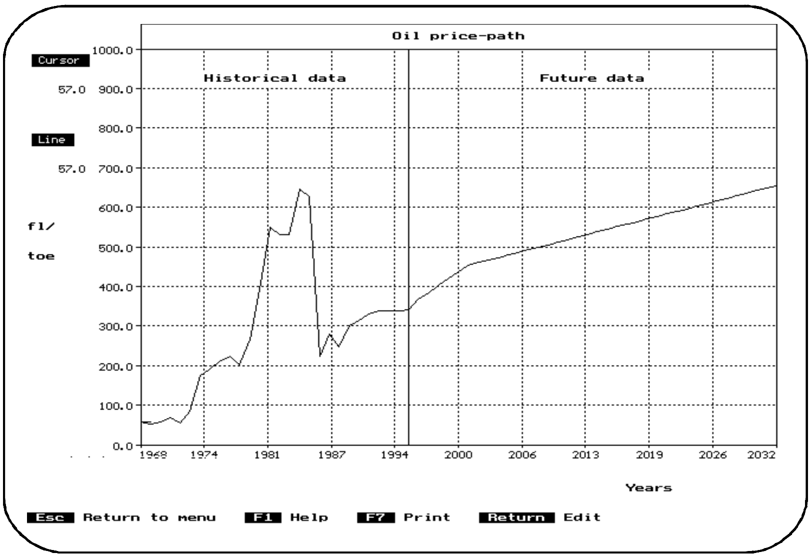
Nr	Power types	Y in	Y Out	Cap.	FT	Ret C	LT	Eff.	SO2 er	NOx em
1	Import	1993	1996	700	I	0	B			
2	Nuclear	1986	2011	16	U	0	B			
3	Nuclear	1973	2004	449	U	0	B			
4	Nuclear	1969	2004	56	U	0	B			
5	Conv. O/G	1986	1997	362	H	0	B	0.41	0.96	100
6	Conv. O/G	1974	1997	459	H	0	B	0.41	1.00	200
7	CHP	1995	2021	225	G	0	M	0.53	0.00	30
8	CHP	1995	2021	310	G	0	M	0.53	0.00	30
9	CHP	1993	2012	67	G	0	M	0.50	0.00	65

↓↑,<**PgDn**>,<**PgUp**> move cursor <**Enter**> select <**Esc**> to menu
<**Del**> delete power station

Screen 20: This screen: "**Retrofit/inspec**", shows the existing plant and the retrofit possibilities. The costs for retrofitting a power plant should be estimated by the user and be filled in, in this table.



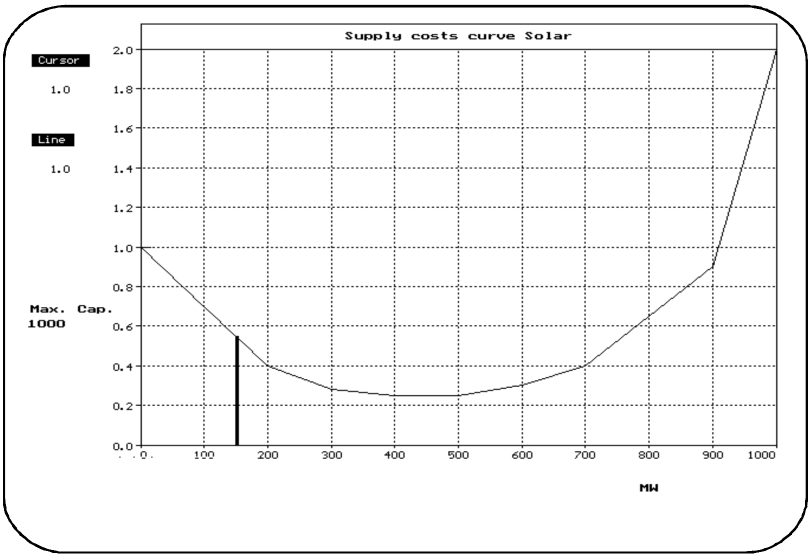
Screen 21: For more experienced users or in a negotiation context, scenario default variables (e.g. the oil price path: cf. *Screen 22* or GDP time-series) can be modified.



Screen 22: In this screen, the oil price path can be modified graphically. Depending on the input data, price paths for other fuels can either be a time-series or can be coupled to the oil price present.

```
File     Decisions     Calculate     Output     Advanced     Set up
                                                Starting values
                                                scen. Variables    ◂
                                                Expert variables   ◂
                            Add offers
                            add Savings
                            LDC curve               Cons. ind.      1
                            supply Costs   ◂        Cons. HH.       2
                            Fuel parameters         Cons. C&S       3
                                                    ST/GT Cont.     4
                                                    GT & GM         5
                                                    District H.     6
                                                    Wind            7
                                                    Pub. Waste      8
                                                    Hydro power     9
                                                    Solar (PV)     10

 <F1> Help                                                 Neth 1995
 ↑↓ move cursor   <Esc> return   <Enter> select
```

Screen 23: Also for experienced users is the option to adjust some parameters, change or add type of power plants and change the supply cost curve for conservation & decentral options.



Screen 24: In this screen, the supply cost curve of solar PV can be adjusted. Solar energy will first become cheaper in this example (150 MW of solar PV is installed in this graph).